

The Cicadas are Coming!

Instructor Background:

Cicadas are most familiar for the deafening sound they can make by using a part of their exoskeleton called the tymbal (Neil & Holderied, 2021). They are thumb-sized, with wings and prominent eyes. Their shape and beautiful wing-vein patterns particularly inspired artists of the Art Deco and Arts and Crafts movements. There are about 100 species of cicadas organized into several genera (Simon et al., 2022). All species of cicada, whether periodic or annual, spend most of their lives underground as nymphs feeding on the sap of tree roots. When the near-surface ground temperature reaches 64oF, they emerge to transform into winged adults, leaving behind shed exoskeletons on trees and buildings. Adult cicadas live mostly to mate, lay eggs, and complete their life cycle (Sota, 2022).

Cicadas are categorized as annual or periodical. **Annual cicadas** belong to four genera and can be found across North America. Individual annual cicadas emerge from the ground in a given area every year after spending 2 to 5 years underground. **Periodical cicadas** emerge from the ground in striking synchrony every 13 or 17 years. A synchronized population of 2-4 closely related species is called a **Brood**. Each of several broods (numbered by Roman numerals) has a distinct territory in the Eastern United States up to the eastern margins of the great plains (see map) (Encyclopedia Britannica, 2024; Fuhr et al. 202). Periodical cicadas consist of seven species, all belonging to the genus *Magicicada*. In contrast, various species of annual cicadas can be found across the continental US and Canada.

In 2024, in addition to annual cicadas, two periodical broods will emerge:

- Brood XIX (the 13-year Great Southern Brood) will appear across the Southeast.
 - Includes *Magicicada neotredecim*, *Magicicada tredecim*, *Magicicada tredecassini*, and *Magicicada tredecula*
- Brood XIII (the 17-year Northern Illinois Brood) will appear across a small area of the Midwest.
 - Includes *Magicicada septendecim*, *Magicicada Cassini*, and *Magicicada septendecula*
- BOTH Brood XIII and Brood XIX will overlap in limited regions of Illinois.

The last time such a co-emergence occurred was 221 years ago, in 1803 (Bartels, 2024).

The Lessons:

The Teaching Tool consists of three separate lessons that can be taught independently or combined over three 50-minute class periods.

Activity 1: Phenomenal Image: Cicada Synchronicity

Time: 50 minutes or 1 class period

Objective: Students make inferences from an illustration depicting the emergence of periodical cicadas and a photo or physical specimen of a cicada's molted shell or exuviae to refine and deepen their understanding of its life cycle. If the season is right and with a bit of luck, molted shells should be easy to find and collect.

Part 1: The Periodical Cicada

Begin the activity by asking students to look closely at the illustration from "The Periodical Cicada" by Charles L. Marlatt, 1907 (Biodiversity Heritage Library) to answer a series of questions.

- What is the illustration depicting? - encourage students to focus on the process occurring in the illustration.
- Circle the nymph - There are two nymphs at the bottom of the tree
- Place a square around the adult phases: The illustration depicts the transition from nymph to adult. Students may place squares around all illustrations where the adult is emerging, or they may only consider the fully winged images to be adult. Allow students to discuss and debate if there is any disagreement.
- Encourage students to share and discuss significant differences between the nymph and the adult. Several differences would be acceptable answers; however, the most obvious is the presence of wings.

Part 2: Cicada Exoskeleton

Compare the illustration to a photograph or physical specimen. If possible, collect several shed cicada exoskeletons and have students make observations while working in small groups. Hand lenses can help. Encourage students to look back at the previous illustration to infer information about the shed exoskeleton, including:

- Where did it come from?
- Why was left behind?
- Where is its former occupant?

Middle School NGSS

MS-LS1-4

- DCI: LS1.B; LS4.C
- CCC: Patterns, Cause and Effect
- SEP: Developing and Using Models

High School NGSS

HS-LS4-4

- DCI: LS4.C
 - CCC: Patterns; Cause and Effect
 - SEP: Developing and Using Models
 - Nature of Science: Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
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Activity 2: What's that Cicada Map Mapping?

Time: 50 minutes or 1 class period

Objective: Students analyze data depicted on a map to speculate about how spatial and temporal distributions might give periodical cicada broods a survival advantage.

Part 1: What's that Cicada Map Mapping?

- Distribute or project the colored map to students in small groups or individually. Before providing context, ask them to list three observations and three questions they have about the map.
- Next, ask students to speculate about the map's purpose, specifically, what it communicates to the reader. Students who know about cicadas may mention broods or the concept of synchronous emergence. More likely student ideas would concern species distributions, or the physical characteristics of species. Nearly any idea is acceptable but good to steer students toward information actually displayed by the map and things relating to biology.

Part 2: Conduct a Quick Survey

- To encourage discussion and peer engagement, give students five minutes or less to circulate the room and survey their peers to assess differing perceptions of the map's purpose. Students should write these responses in the thought bubbles above the stick figures.
- After students have completed the survey or a time limit has passed, ask them to return to their seats.

- Students will use their survey data to identify similarities or differences among the peer responses by working independently or in small groups.
- Finally, after multiple rounds of peer discussions, allow students to update their initial predictions.

Part 3: Mapping Periodical Cicada Broods

- Distribute or project the same map with context revealing its intended purpose. Explain that the map illustrates the emergence of periodical cicadas' time (temporal) and place (spatial). It is also helpful to differentiate between periodical and annual cicadas - which students are likely more familiar with.
- After reintroducing the map, ask students to work in small groups to complete the remaining questions. Students should determine that the map shows temporal and spatial data. They may refer to it as “time and place” or “when and where.” To answer the second question, students must determine if any Broods co-emerge in the same year (time) and if any of those broods overlap on the map (place). Students should conclude that Brood XIX and Brood XIII (who) will overlap in 2024 (when) in Illinois (where).

Middle School NGSS

MS-LS2-2; MS-LS2-4

- DCI: LS2.A; LS2.C
- CCC: Patterns; Cause and Effect; Stability and Change
- SEP: Developing and Using Models; Analyzing and interpreting data
- Nature of Science: Science Addresses Questions About the Natural and Material World

High School NGSS

HS-LS2-2; HS-LS2-8

- DCI: LS2.C, LS2.D
- CCC: Patterns; Stability and Change; Scale, Proportion, and Quantity; Systems and System Models
- SEP: Developing and Using Models: Using Mathematics and Computational Thinking

Activity 3: More About Periodical Cicadas

Video (recommended): If you have time, it's preferable to review the video to determine fit for your students and to choose segments to highlight. An Edpuzzle



version has edited out some potentially objectionable segments. Project the video to the whole group or have students watch individually or in small groups. Instruct students to complete the questions using information from the video and encourage them to relate the video content to the previous Cicada lessons.

- Full Video: <https://youtu.be/9wRdADpIZFs?si=0YNrOXSwWIPPQ11O>
- Edited Version: <https://edpuzzle.com/media/663e63f6535767749f3bfb63>

As an alternative to the video, students answer the questions by doing internet research using what they learned in previous lessons. Encourage (require) students to cite their sources. A citation tool like <https://quillbot.com/citation-generator> can help.

Middle School NGSS

MS-LS1-4; MS-LS2-2; MS-LS2-4

- DCI: LS2.A; LS2.C; LS1.B; LS4.C
- CCC: Patterns, Stability and Change
- SEP: Developing and Using Models; Analyzing and interpreting data
- Nature of Science: Science Addresses Questions About the Natural and Material World

High School NGSS

HS-LS2-2; HS-LS2-8; HS-LS4-4

- DCI: LS2.C; LS2.D; LS4.C
- CCC: Patterns, Stability and Change, Scale, Proportion, and Quantity, Systems and System Models
- SEP: Developing and Using Models; Using Mathematics and Computational Thinking; Scale, Proportion, and Quantity; Systems and System Models
- Connections to Nature of Science: Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

Addition Cicada Resources:

- Cicada Safari: <https://scistarter.org/cicada-safari>
- The 2024 Periodical Cicada Emergence: <https://cicadas.uconn.edu/>
- What to Expect When You're Expecting a Cicada Double Emergence <https://www.fieldmuseum.org/blog/what-to-expect-when-you-re-expecting-a-cicada-double-emergence>
- Maps of Two Cicada Broods, Reunited After 221 Years <https://www.nytimes.com/interactive/2024/science/cicada-maps.html>
- Here come the cicadas! <https://www.fs.usda.gov/features/here-come-cicadas>



- Periodical Cicadas <https://naturalhistory.si.edu/education/teaching-resources/life-science/periodical-cicadas>

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Written and Developed by: Jocelyn Miller, E.O. Wilson Biodiversity Foundation; Jenna Adams, Baltimore Public Schools, Dennis Liu, E.O. Wilson Biodiversity Foundation